



NASA SBIR 2004 Phase I Solicitation

B3.07 Biomass Production for Planetary Missions

Lead Center: KSC

Participating Center(s): ARC, JSC

The production of biomass (in the form of edible food crops) in closed or nearly-closed environments is essential for the future of long-term planetary exploration and human settlement in Moon and Mars base applications. These technologies will lead not only to food production, but also to the reclamation of water, purification of air, and recovery of inedible plant resources in the comprehensive exploration of interplanetary regions. Innovations are solicited in the following areas:

Crop Lighting

- Sources for plant lighting such as, but not limited to, light emitting diodes, high-efficiency lamps or solar collectors suitable for orbital space, interplanetary space, lunar or Martian surface;
- Transmission and distribution systems for plant lighting including, but not limited to, luminaries, light pipes, fiber optics, and optical filters; and
- Heat removal techniques for the plant growth lighting such as, but not limited to, water-jackets, water barriers, and wavelength-specific filters and reflectors.

Water and Nutrient Management Systems

- Technologies for production of crops using hydroponics or solid substrates suitable for orbital space, interplanetary space, lunar or Martian surface;
- Water and nutrient delivery systems;
- Regenerable media for seed germination plant support; and
- Separation and recovery of usable minerals from wastewater and solid waste products for use as a source of mineral nutrients for plant growth.

Environmental Monitoring and Control

Innovations in monitoring and control approaches for plant-production environments, including temperature, humidity, gas composition, and pressure. Gases of interest could include carbon dioxide, oxygen, nitrogen, water

vapor, and ethylene. Development of autonomous control systems integrated with predictive modeling for crop production optimization.

Mechanization and Automation

Innovations in propagation, seeding, and plant biomass processing. Plant biomass processing includes harvesting, separation of inedibles from edibles, cleaning and storage of edibles (seed, vegetable, and tubers) and removal of inedibles for resource-recovery processing.

Facility or System Sanitation

Methods or technologies to identify and prevent excessive build-up of microorganisms within closed plant production systems with emphasis on nutrient delivery systems. Processes to insure pathogen free products through HACCP food safety protocols.

Health Measurement

Remote, direct, and indirect methods of measuring plant health and development using canopy (leaf) spectral signatures or fluorescence to quantify parameters such as rate of photosynthesis, transpiration, respiration, and nutrient uptake. Data acquisition should be noninvasive or remotely sensed using spectral, spatial, and image analysis. System modeling and decision making algorithms may be included.

Sensor Technologies

Innovations are required for development of sensors using miniature, micro- and nanotechnologies for evaluation of the physical and biological parameters in all phases of biomass production. Such sensor arrays include wide-ranging applications of gas and liquid sensors, as well as photo sensors and microbiological community indicators. Innovations are required in all phases of sensor development, including biomass fouling, miniaturization, wireless transmission, multiple-phase and multiple-tasking sensors, and interface with artificial intelligence (AI) data collection systems.

Flight Equipment Support

Innovative hardware and components developed to support life support and biological research in the Space Shuttle, on board the International Space Station, and exploration missions to the Moon, Mars, and beyond. Biomass production investigations using flight-support equipment will be required to meet the demanding requirements for space flight operations, meet the rigorous scientific data collection standards, and produce plants in a controlled environment for research purposes and food. Innovative methods to perform in-flight biomass analyses, including equipment miniaturization, are requested in order to perform remote analyses and to minimize requirements to return in-flight samples. Innovations in whole-package design and in component designs will be required.

Structures

Innovative concepts and designs for autonomous or human tended plant production structures that might be deployed in space habitats, including flight, planetary transit, or planetary surfaces systems. Systems would need to accommodate the capture and distribution of solar light or generated light (e.g., electric lamps) and meet the mass and stowage challenges for spaceflight delivery.